



## Early Journal Content on JSTOR, Free to Anyone in the World

This article is one of nearly 500,000 scholarly works digitized and made freely available to everyone in the world by JSTOR.

Known as the Early Journal Content, this set of works include research articles, news, letters, and other writings published in more than 200 of the oldest leading academic journals. The works date from the mid-seventeenth to the early twentieth centuries.

We encourage people to read and share the Early Journal Content openly and to tell others that this resource exists. People may post this content online or redistribute in any way for non-commercial purposes.

Read more about Early Journal Content at <http://about.jstor.org/participate-jstor/individuals/early-journal-content>.

JSTOR is a digital library of academic journals, books, and primary source objects. JSTOR helps people discover, use, and build upon a wide range of content through a powerful research and teaching platform, and preserves this content for future generations. JSTOR is part of ITHAKA, a not-for-profit organization that also includes Ithaka S+R and Portico. For more information about JSTOR, please contact [support@jstor.org](mailto:support@jstor.org).

# STUDIES ON THE ROTIFER ASPLANCHNIA EBBES- BORNII, WITH SPECIAL REFERENCE TO THE MALE.

GEORGE W. TANNREUTHER,  
ZOÖLOGICAL LABORATORY, UNIVERSITY OF MISSOURI.

## INTRODUCTION.

The rotifers were collected in small rain pools, placed in aquaria with tap water and kept in the laboratory at room temperature, free from direct sunlight. The age of the cultures, when the present work was begun, varied from four months to two years. The rotifers appeared in the different cultures at regular intervals of about six to eight weeks.

The life cycle of *Asplanchnia* is as follows: females hatch from the resting or fertilized eggs. These females (first generation) produce parthenogenetically twenty to thirty offspring, which are likewise females. The latter reproduce parthenogenetically. All of the offspring of one parent, being either all females or males. Thus the females of the second generation may be called male producers or female producers. The life cycle of *Hydatina senta* as described by Shull, in most respects corresponds to the above description.

When the males become sexually mature, impregnation of the male-producing females occurs, and the impregnated females produce resting eggs instead of males or both resting eggs and males. The resting egg stage terminates the active period of each cycle and carries the rotifers to the beginning of the active period of the next following cycle. The active free-swimming period of each cycle continues from two to three weeks. The inactive or resting egg stage of each cycle varies from five to eight weeks. If impregnation of the male producers is prevented, no resting eggs are formed and the females continue to form males parthenogenetically.

If we consider the females that actually produce males the sum total of all male producing females formed, the percentage

of the male producers would be rather low and remain constant regardless of external conditions. But if we include the resting egg producers (potentially male producers) in the sum total of the male producers the percentage under favorable conditions often reaches 90 to 95 per cent.

In this particular rotifer there are two kinds of resting eggs, which require fertilization before development begins. The one (single shelled) develops within the uterus of the parent with the same rapidity as the parthenogenetic forms and hatches out immediately when deposited. The other (double shelled) with the exception of a few early cleavage stages, develops after deposition.

No attempt was made to regulate the food conditions of the different cultures, except the adding of tap water at different times to counteract evaporation. The amount of food available for the rotifers varied greatly during the active periods of the different life cycles. Some of the cultures were almost entirely free from food of any kind, while other cultures were rich in euglenæ and unicellular plants or animals. It was found that the number of male- and female-producing females varied according to the amount and kind of food present. Scarcity of food favored the production of female-producing females. Culture rich in euglenæ and unicellular plants, favored a high production of male-producing females.

Experiments in mating and sex determination have been carried on extensively by Shull, Whitney and others but will not be considered here, since they do not come directly within the domain of the present investigation. However, some very suggestive features on sex determination present themselves in the study of the above rotifer. It is true that certain food conditions favor a high production of male-producing females, but immediately after impregnation, as stated above, these same male-producing females begin the production of resting eggs, or both male and resting eggs, which may alternate in the same female. Again it is not an unusual thing to find within the oviduct of the male-producing female embryo before birth, either mature male eggs or male eggs that have begun to develop, and if impregnation of these male producers occurs after birth, resting eggs

instead are produced later. The question of sex determination from the standpoint of external conditions is rather an intricate problem to attempt to solve, since the same male-producing females are capable of producing simultaneously both males and female-producing females (from thin-shelled resting eggs) under the same food conditions.

#### COMPARATIVE STUDY OF MALE AND FEMALE.

The males with few exceptions as found in the different groups of rotifers are smaller than the females. The cleavage and early development in both sexes are quite similar. Previous investigators have based their results almost entirely on the study and development of the females and have not made a careful study of the degree of development and degeneration as it occurs in the male, more especially when compared with the conditions found in the female.

The development of the parthenogenetic female is represented in the series of diagram A, 1-15, and the parthenogenetic developing male in the series of diagrams B and C, 1-15. In case of the male the series B represents the condition, where degeneration of the male individual is very pronounced. Series C represents the condition of normal development, where only partial degeneration of the male occurs.

#### A. FORMATION AND MATURATION OF OVA.

The ovary of female-producing male individuals and resting eggs and of the female-producing males are quite similar (Figs. 1 and 2). It is composed of a group of very small cells (ova), situated on the convex side of the vitellarium, near the point where the oviduct takes its origin. These small cells are uniform in size, and at regular intervals one of them begins its growth and becomes the mature ovum. Occasionally two begin their growth simultaneously. The growth is very rapid and the cytoplasmic granules pass directly from the vitellarium into the growing egg (Figs. 1 and 2). When growth is complete the egg is separated from the ovary and passed into the upper end of the oviduct where maturation occurs. The origin and formation of the male, female and resting eggs are quite similar. The rest-

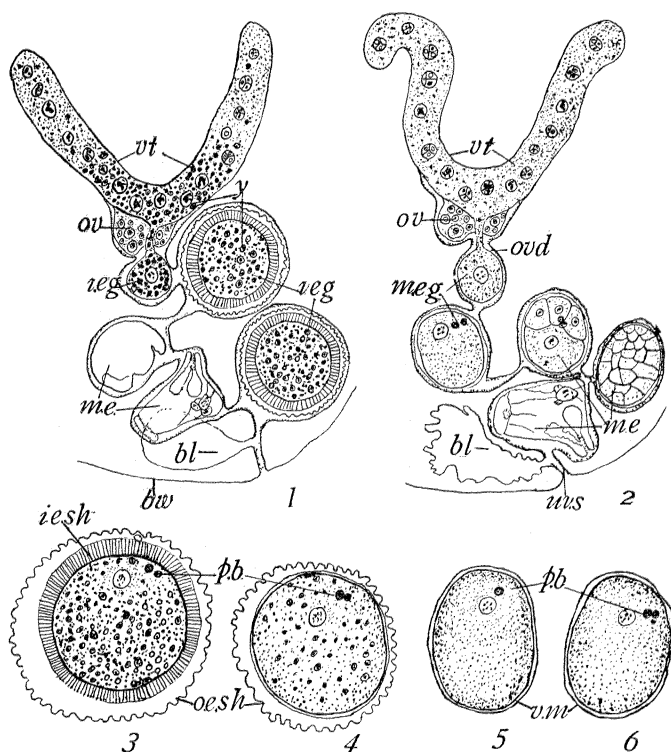


FIG. 1. Represents the reproductive system of a male-producing female, which shows the presence of both male embryos and resting eggs. Where male embryos and resting eggs alternate, the yolk is formed at intervals just preceding the growth of the resting eggs. The figure shows the passage of yolk into the forming resting egg.

FIG. 2. Represents the reproductive system of a male-producing female, which contains male embryos in different stages of development. The vitellarium is free from yolk and shows the passage of cytoplasmic granules into the forming male egg. One of the male embryos shows the condition at time of birth.

FIG. 3. A mature double-shelled resting egg, which is filled with considerable yolk.

FIG. 4. A mature single-shelled resting egg, which contains less yolk than the preceding. Its development is completed within the uterus and hatches immediately after deposition.

FIG. 5. A mature parthenogenetic female egg, which is entirely free from yolk. A single polar body is formed.

FIG. 6. A mature parthenogenetic male egg, which has the same structure as preceding. Two polar bodies are formed. All of the above eggs show the presence of a well-formed vitelline membrane.

ing egg (double shelled) is represented in Fig. 3. The outer shell membrane is external to the vitelline membrane and is formed by a secretion from the uterus. The inner protective membrane is formed from the cytoplasm within the vitelline membrane. Fig. 4 represents the single-shelled resting egg, which contains less yolk than the former. Two polar bodies are formed in either case. The female parthenogenetic egg (Fig. 5) is free from yolk and has a single polar body. The male egg (Fig. 6) with the exception of the two polar bodies is indistinguishable from the female parthenogenetic egg. The cytoplasmic content of the above eggs from the standpoint of quantity is about the same.

Impregnation of the male-producing female brings about a new condition in the formation and growth of the resting egg. The vitellarium instead of remaining transparent as in the formation of the parthenogenetic male and female eggs, becomes filled with numerous spherical yolk bodies, which pass directly from the vitellarium into the growing resting egg (Fig. 1, *r.eg*). These yolk-filled eggs are very dark, and unless fertilization occurs further development stops after maturation. The eggs deteriorate and do not give rise to males as advocated by some of the investigators on rotifers. The growth period of the female, male and resting eggs with the passage of cytoplasmic granules or yolk bodies from the vitellarium into the growing eggs, as well as the maturation stages can be demonstrated under the microscope in the living individual, the entire process requires about one hour. In this particular rotifer there can be no question as to the structural differences in the male and the resting eggs. The male eggs are always transparent, free from yolk and incapable of being fertilized. Whether the male and the resting eggs are the same or not before their growth period begins in the ovary of the male-producing females I am unable to say. There is a possibility of two distinct kinds of ova being present: the one which normally becomes the male egg, the other which requires impregnation before the growth period begins in the formation of the resting egg. The ova that become resting eggs never begin their growth unless impregnation occurs.

## B. CLEAVAGE AND GASTRULATION.

It is not my intention to give a detailed account of the different cleavages. A brief account of the more important stages of development, as they occur in the parthenogenetic female and male will be considered for the purpose of comparison in emphasizing the varying degrees of development and degeneration in these organisms.

The development of *Asplanchnia ebbesbornii* has not been worked out by previous investigators. Complete development (except of the double-shelled resting egg), occurs within the oviduct and uterus of the parent. The animals are extremely transparent so that it is possible to make a study of the various cleavage stages as they occur within the living body. The eggs are extremely plastic with a well-defined vitelline membrane (Figs. 5 and 6). The nuclear activities are distinct in the living cells, and the order, rate and direction of the cleavage spindles can be followed without any difficulty. Preserved material if stained, dehydrated, cleared and mounted in damar immediately after fixation, serves as a fine check in the study of cleavage. The cell lineage of *Asplanchnia Herricki*, from early cleavage to late gastrula, was worked out by Jennings. His entire work was based upon the study of preserved material. The rotifers were fixed in toto, the eggs dissected out and studied under the cover slip. With few exceptions he was unable to verify the presence of a distinct egg membrane. He seldomly found more than a single embryo in the same uterus.

The cell lineage of *Asplanchnia ebbesbornii*, for the most part is a confirmation of Jennings' results. The eggs are somewhat elliptical with the cleavage nucleus nearer the anterior end (A-C, 1). The first cleavage plane passes through the region of the polar body or bodies and divides the egg into two very unequal cells (A-C, 2). The second cleavage occurs at an angle of about forty-five degrees to that of the first, dividing the anterior smaller cell equally and the posterior larger cell unequally (A-C, 3 and 4). The four macromeres show considerable uniformity in the condition of their cytoplasmic structures. The region immediately surrounding the nuclei is more transparent and free from cytoplasmic granules. In the third cleavage the

large cell *D* (A-C, 4) divides first. The ectomere  $d^1$  is budded off in an upper anterior direction on the median dorsal side and covers the posterior ends of the macromeres *C*, *B* and *A*. The cells *C*, *B* and *A* before division are drawn out in an antero-posterior direction and divide nearly equal. The ectomeres  $c^1$ ,  $b^1$  and  $a^1$  are on the same level with their parent cells, as shown in the small diagram. During the fourth cleavage in the formation of the sixteen cell stage (A-C, 5)  $d^2$  is the first cell formed, which is budded off from *D* in a dorso-anterior direction. The division of  $d^1$  follows immediately. Next the macromeres *C*, *B* and *A* with their ectomeres divide, thus producing a twelve, fourteen and sixteen cell stage respectively. The embryo is now composed of four rows with four cells each (A-C, 5). Jennings describes the sixteen-celled embryo as being composed of four layers, each layer containing a single derivative of each quadrant. The first layer at the macromere end is designated as ventral and the cells are labelled accordingly. The number of layers increase with later cleavage.

The cleavage forms of the male and the female embryos at the sixteen cell stage are indistinguishable. The shape of the embryos, the size of the cells and the direction of the various cleavages (A-C, 5) are about the same. The only evidence we have to distinguish the male embryo at this stage is the presence of the two polar bodies, or more mature embryos in the same uterus. In the fifth cleavage all of the cells except the macromere *D* divide in a more transverse direction: thus doubling the number of rows on the surface. The inner ends of the cleavage cells withdraw towards the exterior and produce a central cavity, which is later occupied by the large cell *D*. Before the fifth cleavage is completed the anterior end of the cell *D* is partially covered by the cleavage cell immediately in front of it. The sixth cleavage is more irregular and doubles the number of cells in each of the eight rows.

Gastrulation is a double process, while the cells are passing posteriorly over the macromere *D*, the cell itself is moving into the central cavity. The entire process requires about fifty minutes and can be demonstrated in the living egg. The large cell *D*, which is now designated by the letter *E*, is destined to



play a very important rôle in the future development of the individual. The derivatives of  $E$  give rise to most of the digestive tract, the reproductive system and a few muscle fibers. All other structures are derived from the surface cells, which form a rather deep epithelial layer around the central cell  $E$ .

Diagrams A-C, 6, represent late cleavage stages in which  $E$  has passed into the interior of the embryo and is no longer visible from the exterior. A little later stage (A-C, 7) than the preceding, shows the second cleavage of  $E$  as represented in an optical section from dorsal view. Diagrams A-C, 8, represent an embryo of either sex in optical section, as viewed from the left side with five large central cells derived from  $E$ . The small stippled space between the large cells and the outer epithelium represents the first indication of the presence of the future body cavity.

#### C. DIFFERENTIATION OF THE CENTRAL CELLS.

The large central cells  $E^{2.1.1}$  and  $E^{2.1.2}$  give rise to the reproductive organs, and the derivatives of the large central cells  $E^{1.1}$ ,  $E^{2.2.1}$  and  $E^{2.2.2}$  produce most of the digestive system. The large central cells now divide very rapidly and fill the interior of the embryo (A-C, 9). These central cells as stated above become differentiated into two distinct regions, the entodermal (*st*) and the reproductive portion (*r.o.*), which shows the presence of darker granules and later gives rise to the reproductive organs proper. A few muscle fibers are derived from the central mass of cells, which are directly concerned in the movements of the reproductive organs and the stomach with the digestive glands

#### D. EMBRYONIC FOOT AND STOMODÆUM.

The slight swelling at the lower posterior end (A-C, 9 ft.) marks the beginning of the foot, an embryonic structure. Later it becomes well developed in both sexes and shows the presence of two distinct toes, which no doubt persisted as a functional structure in its ancestors. The foot completely disappears before the birth of the individual. Diagrams A-C, 10 show the early stages in the formation of the stomodæum (*sto.*). The embryo is considerably curved upon itself and occasions the close proximity

of the embryonic foot and the mouth. A distinct epithelium or hypodermis is present. The stomodæum in the male embryo is less prominent (B-C, 10), than in the female. The buccal pouch and pharynx is derived from this invagination. The posterior wall of the pharynx (A-C, 11) is more prominent in the female and contributes directly to the formation of the jaws or trophi. There is no indication of the formation of trophi in the male embryos.

#### E. THE RÔLE OF THE ENTODERMAL AND THE REPRODUCTIVE CELLS.

The early differentiation of the derivatives of *E* bears a striking resemblance in the two sexes (A-C, 11). Two distinct regions are readily recognized. The upper and anterior part (*st.*) becomes continuous with the walls of the pharynx, and in the female (A, 12-13), gives rise to the œsophagus, the stomach and the digestive glands. The lower and more posterior portion (*r.o.*) becomes differentiated into the vitellarium, ovary, oviduct and uterus as indicated in the A series of figures. Beginning at the point of development as indicated in the series A-C, 11 the entodermal cells (*st.*), play quite a different rôle in the two sexes. In the male embryo (B-C, 11) the cells (*st.*) fuse with the wall of the invaginated pharynx as in the female, but do not give rise to any permanent structures. Later this entodermal group of cells lose their connection with the pharyngeal wall (C, 12), and are gradually utilized as food. The reproductive portion (*ts.*) gives rise to the testis and vas-deferens (C, 14). The male embryo as indicated in series B, 11-15, with the exception of the reproductive cells, undergoes an almost complete degeneration. In B, 11 the embryo corresponds to that of the normal male (C, 11), but later all of the non-reproductive cells deteriorate and are utilized by the embryo. When the sperm have reached their maturity, the embryo is represented by a large sperm sac (B, 15) within the delicate body wall or hypodermis. A portion of the trochal disc and cilia often persist.

In series C, 11-15, which represents the development of the normal male as it occurs in *Asplanchnia ebbesbornii*, degeneration occurs only in the digestive system. The early development

however, is comparable to the conditions found in the female (A, 11). The cells from which the œsophagus, stomach and digestive glands are formed in the female, become independent of the pharyngeal wall in the male (C, 12-13), and persist more as a compact mass of cells, entirely free from any lumen (C, 14-15). The position of these cells within the body cavity is indicated in figures C, 11-15. This group of cells gradually becomes smaller and takes up a final position in the dorso-posterior region of the body cavity, where they are held in position by delicate muscle fibers. In extreme cases, when the male lives longer than normal, the cells completely disappear within the body cavity and no doubt serve as food. The reproductive organs are well developed (C, 11-15) and communicate with the urinogenital sinus by means of the vas deferens (C, 14). The urinogenital sinus is ciliated, which aids in the passage of the sperm. No attempt was made to represent more than a few of the muscle fibers within the body cavity. The excretory system which is well developed in the male is not shown.

The development of the digestive system reaches its greatest differentiation in the female as represented in series A. The stomach becomes a rather large strongly ciliated pouch, and communicates with the pharynx by means of a slender œsophagus, which is capable of considerable distention (A, 12-13). The stomach ends blindly. There is no indication of a rudimentary intestine in the developing embryo. The bladder (contractile vacuole) is formed by an anterior evagination of the wall of the urinogenital sinus.

#### ACTIVITIES OF THE MALE.

Varying degrees of degeneration are found in the males of *Asplanchnia ebbesbornii*, ranging from those without a functional digestive system, to those with all organs wanting except a large testis and the delicate hypodermis. The latter is little more than a sperm sac. In both instances however, the sperm are functional and capable of fertilizing the resting eggs. The methods of fertilization are rather unique. The normal free-swimming male is sexually mature at birth, and true intromission occurs at the urinogenital sinus (cloaca) with either kind of female. In the

female-producing female, fertilization is ineffective and the female continues to reproduce parthenogenetically. In the male-producing female, after impregnation takes place, either all resting eggs are formed or male and resting eggs. The alternating of the two kinds of eggs occurs more frequently when few sperm are present in the oviduct.

The uterus of the male-producing female may contain embryos ranging from early cleavage to late development (Fig. 2), but if at this point impregnation occurs, yolk spherules are formed within the vitellarium and all of the following eggs formed become true resting eggs. Maturation of the male and resting eggs occurs immediately after their separation from the ovary at the end of the growth period.

The sperm of the sexually mature males before their birth (Fig. 7, *m.e.2*) may be deposited into the uterus of the parent and bring about the production of resting eggs (Fig. 7, *r.eg.*) as above. In case of the extreme degenerate males (B, 11-15 and Fig. 7, *m.e.1*) the sperm sac and the delicate body wall break down, the sperm are set free in the uterus and the production and fertilization of the resting eggs follow. Again the sperm sac (B, 15) with the delicate body wall (degenerate male) may be deposited intact into the water and later the mature sperm are set free and finally get into the uterus of the different individuals. The independent entrance of the sperm is rather a simple process, since the urinogenital sinus and the lower end of the uterus is constantly being partially everted and inverted and during these activities the sperm make their entrance into the uterus. One of the peculiar activities of the normal male is the occasional eversion of the lower end of the vas deferens and discharge of the mature sperm into the water. The entrance of the sperm into the uterus independently of the male is a common method in this particular rotifer and makes possible the fertilization of a greater number of resting eggs. Those instances in which the male embryos and the resting eggs alternate in the same uterus, are often due to the later method, where sperm enter at different intervals.

The free-swimming males are rather scarce, less than one per cent. at any time, when compared with the total number of

rotifers present in the different cultures. At the close of the active period of any one cycle, nearly all of the male-producing females, within a few hours show the presence of resting eggs within the uterus. These conditions are made possible by the independent entrance of the sperm.

In general the characteristics applying to the male rotifers

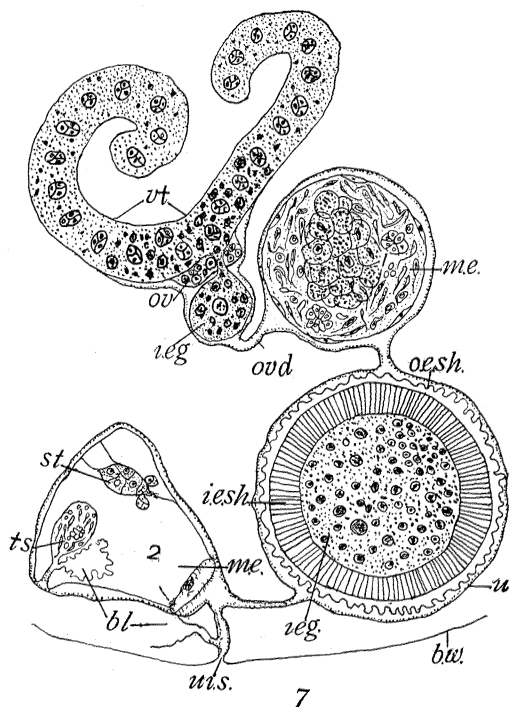


FIG. 7. Reproductive organs of a male-producing female, which contains both male embryos and resting eggs; *r.eg.*, formation of resting egg; *m.e.1.*, male embryo which shows a case of extreme degeneration, with a very delicate body wall. The central mass represents a few somatic cells that still persist. No bounding membrane of sperm sac was formed, and the sperm as development progressed were left free in the body cavity. Later the somatic cells are all utilized and the body wall becomes the bounding membrane of the large sperm sac; *m.e.2* shows a completely developed male embryo at time of birth, with testis containing mature sperm; *r.eg.*, resting egg with two distinct protective shell membranes.

as a group are the following: diminutive size, the total absence of the mouth, of the pharynx, of the jaws, of the oesophagus, of the gastric glands and of the stomach and the intestine. The

ovary is replaced by the testis. In some forms, however, like *Rhinops vitrea*, the male possesses all of the above mentioned points and does not show any indication of degeneration. In other forms as in *Polyarthra platyptera*, the male rotifer resembles a vorticella detached from its stem. Why degeneration is carried much farther in some species than in others is rather a puzzling problem. In *Asplanchnia ebbesbornii*, the varying degrees of degeneration are greater than in any previously reported species. Without the presence of the few actively free-swimming males, and more especially a knowledge of their embryonic development, the extremely degenerate males (B, 15 and Fig. 7, *m.e.1*) would in all probability remain unknown. It would not at all be surprising, if in some of the groups where males have not been reported, that extremely degenerate or parasitic males exist as described above.

COLUMBIA, MO.,  
April 30, 1919.

#### LITERATURE CITED.

Hudson, C. T., and Gosse, P. H.

'89 The Rotifera or Wheel-Animalcules. Two vols. London.

Jennings, H. S.

'95 The Early Development of *Asplanchnia Herricki*. Bull. Mus. Comp. Zool. Harvard.

'02 Rotatoria of the U. S., II. A Monography of the Ratulidæ. Bull. M. S. Fish Comm.

Rousselet, C. F.

'97 On the Male of *Rhinops vitrea*. Journ. R. Mic. Soc., Vol. 17.

Shull, F. A.

'10 Studies in the Life Cycle of *Hydatina senta*. I., Artificial Control of the Transition from Parthenogenetic to the Sexual Method of Reproduction. Journ. Exp. Zool., Vol. 8.

Tannreuther, Geo. W.

The Development of *Asplanchnia ebbesbornii* (Rotifer). Journ. Morph., Manuscript in press.

Whitney, D. D.

'10 The Influence of External Conditions upon the Life Cycle of *Hydatina senta*. Science, N.S., Vol. 32, no. 819, Sept. 9.

Zelinka, C.

'92 Studien uber Radertiere, III. Zeitschr. für Wis. Zool., Vol. 53.

## REFERENCE LETTERS.

- |  |  |
|--|--|
| <i>a.</i> , anterior,                      | <i>o.e.sh.</i> , outer egg shell membrane, |
| <i>b.c.</i> , body cavity,                 | <i>ov.</i> , ovary,                        |
| <i>bl.</i> , bladder,                      | <i>ovd.</i> , oviduct,                     |
| <i>br.</i> , brain,                        | <i>p.</i> , posterior,                     |
| <i>bu.c.</i> , buccal cavity,              | <i>p.b.</i> , polar body or bodies,        |
| <i>b.w.</i> , body wall,                   | <i>ph.</i> , pharynx,                      |
| <i>c.</i> , cilia,                         | <i>phw.</i> , pharyngeal wall,             |
| <i>c.o.</i> , copulating organ,            | <i>pr.</i> , proctodæum,                   |
| <i>cp.</i> , corpuscle,                    | <i>r.</i> , right,                         |
| <i>d.</i> , dorsal,                        | <i>r.eg.</i> , resting egg,                |
| <i>d.g.</i> , digestive glands,            | <i>r.o.</i> , reproductive organs,         |
| <i>ect.</i> , ectoderm,                    | <i>st.</i> , stomach,                      |
| <i>ent.</i> , entoderm,                    | <i>sto.</i> , stomodæum,                   |
| <i>ft.</i> , foot,                         | <i>ts.</i> , testis,                       |
| <i>i.e.sh.</i> , inner egg shell membrane, | <i>u.</i> , uterus,                        |
| <i>l.</i> , left,                          | <i>ur.s.</i> , urino-genital sinus,        |
| <i>m.</i> , muscle,                        | <i>v.</i> , ventral,                       |
| <i>m.e.</i> , male embryo,                 | <i>v.m.</i> , vitelline membrane,          |
| <i>m.eg.</i> , male egg,                   | <i>vt.</i> , vitellarium,                  |
| <i>mo.</i> , mouth,                        | <i>y.</i> , yolk.                          |
| <i>oe.</i> , œsophagus,                    |  |

DESCRIPTION AND EXPLANATION OF SERIES OF DIAGRAMS  
A, B AND C.

All drawings were made with the aid of the camera lucida, under a magnification of about one hundred and fifty diameters and reduced one half. The drawings were made from either living or mounted embryos and checked. Stippling was adopted for sake of clearness. The text figures in the A series 1-15, represent the conditions found in the female. Fig. A, 15 shows the condition of the female embryo at the time of birth. The B series 1-15, represent the male embryos that have undergone extreme degeneration. Fig. B, 15 is characteristic of the end stage of development. The C series 1-15 gives the different stages in the development of the normal male with the degenerative digestive system. The buccal pouch and pharynx disappear before birth. Fig. C, 15 represents the condition of normal male individual at the time of birth.